Comparison tables: BBOB 2010 noisy testbed in 10-D

The BBOBies

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Abstract

This document provides tabular results of the workshop for Black-Box Optimization Benchmarking at GECCO 2010, see `http://coco.gforge.inria.fr/doku.php?id=bbob-2010`. More than 30 algorithms have been tested on 24 benchmark functions in dimensions between 2 and 40. A description of the used objective functions can be found in [10, 6]. The experimental set-up is described in [9].

The performance measure provided in the following tables is the expected number of objective function evaluations to reach a given target function value (ERT, expected running time), divided by the respective value for the best algorithm. Consequently, the best (smallest) value is 1 and the value 1 appears in each column at least once. See [9] for details on how ERT is obtained. Bold entries in the table correspond to values below 3 or the top-three best values.

Table 1: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{101}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

101 Sphere moderate Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.59	5.5	12	18	22	24	26	28	31	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	8.4	6.4	4.8	4.3	4.4	4.8	5.1	5.5	6.4	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**2.4**	3.4	**2.6**	**2.4**	**2.7**	3.0	3.2	3.4	4.0	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	4.9	**2.7**	**2.0**	**1.9**	**2.1**	**2.4**	**2.6**	**2.8**	3.3	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	9.1	6.5	4.4	4.2	4.4	4.9	5.3	5.8	6.7	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1.6**	**2.4**	**2.0**	**2.0**	**2.2**	**2.4**	**2.7**	**2.8**	3.4	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1.8**	**1.9**	**1.7**	**1.6**	**1.9**	**2.1**	**2.3**	**2.4**	**2.9**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**2.1**	**1.5**	**1.3**	**1.3**	**1.4**	**1.6**	**1.8**	**1.9**	**2.3**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**2.4**	**2.2**	**1.8**	**1.7**	**1.8**	**2.1**	**2.3**	**2.5**	**2.9**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	3.3	**1.4**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	153	43	16	11	8.5	8.3	8.5	8.9	9.1	10	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1.1**	**2.4**	**2.4**	**2.4**	**2.7**	3.1	3.4	3.7	4.4	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.9**	**2.7**	**2.5**	**2.5**	**2.9**	3.2	3.6	3.8	4.4	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	7.9	11	8.9	10	12	12	13	16	CMA+DE-MOS [12]
NEWUOA	**1**	**2.5**	**1**	**1**	**1.1**	**1.4**	**1.5**	**1.6**	**1.7**	**2.1**	NEWUOA [15]
Basic RCGA	**1**	**1.2**	13	21	28	40	97	175	214	274	Basic RCGA [16]
SPSA	104	30	2098	1945	2334	3543	4564	4869	5882	*34e-5/1e5*	SPSA [8]

Table 2: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{102}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

102 Sphere moderate unif

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.41	7.5	13	18	23	27	32	37	52	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	12	5.0	4.6	4.9	4.7	4.8	4.8	4.9	4.6	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	6.0	**2.5**	**2.4**	**2.6**	**2.6**	**2.6**	**2.7**	**2.7**	**2.4**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	5.8	**1.7**	**2.0**	**2.1**	**2.1**	**2.2**	**2.2**	**2.2**	**2.0**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	6.3	7.7	6.5	6.5	6.0	6.2	6.0	6.2	6.9	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	5.3	**2.0**	**2.0**	**2.3**	**2.3**	**2.4**	**2.4**	**2.4**	**2.2**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1.9**	**1.6**	**1.6**	**1.7**	**1.8**	**1.9**	**1.9**	**2.0**	**1.8**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	3.5	**1.2**	**1.4**	**1.5**	**1.5**	**1.6**	**1.6**	**1.6**	**1.4**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	4.1	**1.6**	**1.5**	**1.7**	**1.8**	**1.8**	**1.9**	**1.9**	**1.8**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	7.5	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	147	60	12	10	10	8.9	8.4	8.0	7.7	6.6	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**2.4**	**1.7**	**2.2**	**2.5**	**2.6**	**2.7**	**2.8**	**2.9**	**2.5**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.5**	**1.8**	**2.3**	**2.6**	**2.6**	**2.7**	**2.8**	**2.9**	**2.6**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.5**	6.7	10	9.3	10	11	10	11	9.4	CMA+DE-MOS [12]
NEWUOA	**1**	4.4	**1.2**	**2.5**	9.0	27	40	60	105	317	NEWUOA [15]
Basic RCGA	**1**	**1**	9.1	18	29	38	85	143	168	165	Basic RCGA [16]
SPSA	124	45	53809	1.08e5	*21e+0/1e5*	.	.	.	.	.	SPSA [8]

Table 3: 10-D, running time excess ERT/ERT_{best} on f_{103}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

103 Sphere moderate Cauchy

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	0.10	0.53	6.2	13	22	31	41	49	58	76	ERT_{best}/D
(1,2)-CMA-ES	**1**	6.5	6.0	4.3	3.6	3.4	3.2	3.2	3.2	3.3	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	5.1	**2.9**	**2.2**	**1.9**	**1.8**	**1.8**	**1.8**	**1.9**	**1.8**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	3.1	**2.6**	**2.1**	**1.7**	**1.6**	**1.5**	**1.5**	**1.5**	**1.5**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	4.9	5.1	3.8	3.1	**2.8**	**2.7**	**2.8**	**2.9**	**2.9**	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**3.0**	**2.5**	**2.0**	**1.7**	**1.6**	**1.6**	**1.6**	**1.6**	**1.7**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**2.5**	**2.0**	**1.6**	**1.5**	**1.4**	**1.3**	**1.4**	**1.4**	**1.4**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**2.7**	**1.5**	**1.2**	**1.1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	3.2	**2.0**	**1.5**	**1.4**	**1.3**	**1.2**	**1.3**	**1.3**	**1.3**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	5.9	**1.3**	**1**	**1**	3.1	22	74	948	*39e-6/8e3*	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	121	42	14	8.9	6.7	5.5	4.8	4.8	4.8	4.8	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1.5**	**2.1**	**2.1**	**2.0**	**1.9**	**1.8**	**1.9**	**1.9**	**1.9**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**2.0**	**2.1**	**2.1**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.1**	6.8	10	7.2	7.5	7.3	8.2	8.1	8.6	CMA+DE-MOS [12]
NEWUOA	**1**	**2.8**	**1**	**1.2**	**2.9**	13	83	179	656	*15e-5/6e3*	NEWUOA [15]
Basic RCGA	**1**	**1**	14	19	25	34	73	115	125	121	Basic RCGA [16]
SPSA	105	138	48	38	32	40	930	3126	*18e-5/1e5*	.	SPSA [8]

Table 4: 10-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ on f_{104}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

104 Rosenbrock moderate Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
$\mathrm{ERT}_{\mathrm{best}}$/D	4.8	23	45	1566	1825	1956	2034	2089	2127	2187	$\mathrm{ERT}_{\mathrm{best}}$/D
(1,2)-CMA-ES	8.9	4.6	5.1	28	*24e-1/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	4.7	3.5	**2.8**	7.0	38	74	71	69	*72e-2/1e4*	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	3.9	**2.6**	**2.0**	10	24	72	69	67	*16e-1/1e4*	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	14	6.3	4.4	16	*15e-1/1e4*	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	3.6	3.2	**2.8**	4.7	79	*56e-2/1e4*	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**2.9**	**1.3**	**1.7**	20	37	72	69	67	66	64	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**2.1**	**2.3**	**1.6**	8.2	39	*92e-2/1e4*	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	3.1	**2.4**	**1.9**	5.2	24	73	*40e-2/1e4*	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	**1**	4.5	20	*67e-2/8e3*	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	20	6.1	4.8	24	21	19	19	18	18	18	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	3.7	**1.6**	**1.6**	**1.3**	**1.2**	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	3.7	**2.5**	**2.9**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-CMA-ES [14]
CMA+DE-MOS	12	5.7	5.3	**2.2**	**2.3**	**2.4**	**2.6**	**2.7**	**2.7**	**2.7**	CMA+DE-MOS [12]
NEWUOA	**1.0**	**2.1**	7.2	**2.9**	43	*55e-2/5e3*	.	.	.	.	NEWUOA [15]
Basic RCGA	16	15	99	*73e-1/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	81	31	*70e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 5: 10-D, running time excess ERT/ERT_{best} on f_{105}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

105 Rosenbrock moderate unif

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	3.1	38	97	4218	4463	4596	4682	4743	4797	4894	ERT_{best}/D
(1,2)-CMA-ES	16	4.4	4.5	7.6	32	*21e-1/1e4*	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	7.8	**1.6**	**1.6**	5.2	*19e-1/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	5.6	**2.3**	**1.7**	3.8	10	32	*14e-1/1e4*	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	16	5.2	5.5	16	33	*35e-1/1e4*	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	5.9	**1.7**	**1.3**	3.8	15	*15e-1/1e4*	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	4.7	**1.6**	**1.1**	6.0	16	*20e-1/1e4*	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**3.6**	**1.7**	**1.4**	3.4	16	*59e-2/1e4*	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	4.6	**1.3**	**1.1**	3.1	6.0	15	31	*38e-2/1e4*	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1.9**	**1.5**	**2.4**	**2.6**	**5.9**	26	*88e-2/8e3*	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	31	4.3	**2.4**	155	147	142	140	138	137	287	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	5.1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	6.2	**1.2**	**2.2**	**1.2**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	IPOP-CMA-ES [14]
CMA+DE-MOS	22	3.4	**2.3**	6.5	6.2	**6.0**	**5.9**	**5.9**	**5.8**	**5.7**	CMA+DE-MOS [12]
NEWUOA	**1**	**1.0**	11	5.2	*52e-1/5e3*	.	.	.	.	.	NEWUOA [15]
Basic RCGA	28	8.8	44	167	*61e-1/5e4*	.	.	.	.	.	Basic RCGA [16]
SPSA	84	18	*70e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 6: 10-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ on f_{106}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

106 Rosenbrock moderate Cauchy

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
$\mathrm{ERT}_{\mathrm{best}}$/D	3.4	13	36	289	370	409	433	449	463	487	$\mathrm{ERT}_{\mathrm{best}}$/D
(1,2)-CMA-ES	15	10	6.6	5.4	5.2	5.2	5.1	5.1	5.1	5.1	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	6.4	3.7	**2.5**	**2.7**	**2.6**	**2.6**	**2.5**	**2.5**	**2.5**	**2.4**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	6.3	4.8	**2.5**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.7**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	12	12	6.4	9.4	8.6	8.2	8.0	7.9	7.8	7.6	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	5.1	3.5	**2.0**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	4.7	3.2	**1.8**	**1.7**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**3.0**	**1.6**	**1.4**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	5.0	3.5	**2.0**	**1.9**	**1.8**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1.5**	**1**	**1**	6.4	40	325	*13e-2/9e3*	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	24	10	5.2	3.6	3.4	3.4	3.4	3.5	3.6	4.0	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	4.9	**2.8**	**1.9**	**2.1**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	4.8	3.5	**2.3**	**2.4**	**2.5**	**2.5**	**2.5**	**2.6**	**2.6**	**2.5**	IPOP-CMA-ES [14]
CMA+DE-MOS	19	10	6.3	4.0	3.7	3.7	3.7	3.8	3.8	4.0	CMA+DE-MOS [12]
NEWUOA	**1**	**1.3**	**1.3**	8.9	29	52	*11e-2/7e3*	.	.	.	NEWUOA [15]
Basic RCGA	20	22	110	549	923	1778	*66e-1/5e4*	.	.	.	Basic RCGA [16]
SPSA	431	1779	18171	*16e+0/1e5*	.	.	.	.	.	.	SPSA [8]

Table 7: 10-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ on f_{107}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

107 Sphere Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
$\mathrm{ERT}_{\mathrm{best}}$/D	0.10	0.24	80	194	360	560	738	854	1016	1179	$\mathrm{ERT}_{\mathrm{best}}$/D
(1,2)-CMA-ES	**1**	213	233	*11e+0/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	9.0	18	734	*35e-1/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	22	26	750	*54e-1/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	173	824	*14e+0/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	53	42	*54e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	12	15	162	*21e-1/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	71	11	*34e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	8.2	42	347	*54e-1/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	13	267	*15e+0/7e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	113	81	**1.5**	**1.6**	**2.3**	**3.2**	**3.3**	**5.9**	**6.6**	21	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**2.5**	**1.1**	**1.3**	**1.5**	**1.2**	**1.0**	**1**	**1.1**	**1.1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	4.1	**1**	**1**	**1**	**1**	**1**	**1.1**	**1**	**1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**2.5**	18	75	48	33	30	26	24	21	CMA+DE-MOS [12]
NEWUOA	**1**	6.4	153	*23e+0/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	3.9	3.9	3.2	3.2	4.6	6.5	7.1	**7.8**	Basic RCGA [16]
SPSA	82	60	17402	*28e+0/1e5*	.	.	.	.	.	.	SPSA [8]

Table 8: 10-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ on f_{108}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

108 Sphere unif

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
$\mathrm{ERT}_{\mathrm{best}}$/D	0.10	0.51	785	1992	3283	5974	7657	11196	13940	23700	$\mathrm{ERT}_{\mathrm{best}}$/D
(1,2)-CMA-ES	**1**	198	*28e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	309	*26e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	180	*29e+0/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	148	*27e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	180	85	*18e+0/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	188	190	*17e+0/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	138	42	*16e+0/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	175	*22e+0/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	279	*27e+0/7e3*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	11234	4430	**5.8**	**5.5**	**6.2**	**5.7**	**6.6**	**6.0**	**10**	**15**	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	73	**1.3**	**1**	**1.4**	**1.1**	**1.4**	**1.2**	**1.4**	**1.1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**12**	**1**	**1.0**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.2**	58	756	*74e-1/1e5*	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	116	*28e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	5.9	356	*21e-1/5e4*	.	.	.	.	.	Basic RCGA [16]
SPSA	3022	1591	7.2	35	*78e-2/1e5*	.	.	.	.	.	SPSA [8]

Table 9: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{109}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

109 Sphere Cauchy

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.44	9.4	20	33	45	60	77	93	127	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	13	4.4	3.5	4.2	4.1	4.2	4.2	4.5	4.8	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	7.1	**1.8**	**1.7**	**1.7**	**2.0**	**1.9**	**1.9**	**2.0**	**2.0**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	6.5	**1.7**	**1.4**	**1.4**	**1.5**	**1.5**	**1.5**	**1.5**	**1.4**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	12	4.1	3.7	3.6	3.5	3.5	3.5	3.8	4.0	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	3.6	**1.6**	**1.6**	**1.6**	**1.9**	**2.0**	**2.1**	**2.2**	**2.3**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	3.0	**1.2**	**1.2**	**1.3**	**1.5**	**1.6**	**1.6**	**1.6**	**1.7**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**2.7**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	4.4	**1.3**	**1.4**	**1.4**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	4.5	3.3	55	1014	*31e-2/7e3*	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	125	46	9.1	6.8	5.4	884	*49e-4/1e5*	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**2.3**	**1.3**	**1.7**	**1.8**	**2.0**	**2.1**	**2.2**	**2.3**	**2.3**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.4**	**1.3**	**1.5**	**1.7**	**1.9**	**2.0**	**2.0**	**2.1**	**2.1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.3**	4.6	6.7	7.3	8.2	9.4	10	10	11	CMA+DE-MOS [12]
NEWUOA	**1**	3.7	3.6	112	*57e-2/4e3*	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	8.3	15	18	42	90	92	89	78	Basic RCGA [16]
SPSA	101	167	147	532	19908	*36e-2/1e5*	.	.	.	.	SPSA [8]

Table 10: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{110}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

110 Rosenbrock Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	33	198	1028	1.55e6	∞	∞	∞	∞	∞	∞	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	*50e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	43	113	*16e+1/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	130	725	*44e+1/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*65e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	38	163	*11e+1/1e4*	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	8.4	21	*64e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	15	25	*79e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	52	337	*21e+1/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	658	*16e+2/7e3*	.	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	15	8.5	6.2	*76e-1/1e5*	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1.2**	**1.8**	**1.0**	*55e-1/1e6*	.	.	.	.	.	.	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1**	*57e-1/1e6*	.	.	.	.	.	.	IPOP-CMA-ES [14]
CMA+DE-MOS	9.0	6.4	14	**1**	*74e-1/1e5*	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	106	*83e+1/4e3*	.	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**4.0**	**3.7**	**3.0**	*85e-1/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	71	632	*10e+1/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 11: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{111}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

111 Rosenbrock unif

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	242	924	5957	∞	∞	∞	∞	∞	∞	∞	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	604	*68e+2/1e4*	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	590	*45e+2/1e4*	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	*76e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*65e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	*46e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	192	*21e+2/1e4*	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	191	*43e+2/1e4*	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	617	*46e+2/1e4*	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	418	*10e+3/7e3*	.	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	17	11	**11**	*93e-1/1e5*	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1.3**	**1**	**1**	*70e-1/9e5*	.	.	.	.	.	.	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.2**	**1.2**	*70e-1/1e6*	.	.	.	.	.	.	IPOP-CMA-ES [14]
CMA+DE-MOS	27	36	21	*89e-1/1e5*	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	*74e+2/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1.5**	**1.2**	35	*10e+0/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	15	74	*87e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 12: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{112}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

112 Rosenbrock Cauchy

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	3.7	15	68	652	813	888	924	958	986	1039	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	14	7.7	**2.6**	11	11	12	14	14	17	19	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	5.5	3.7	**1.9**	**2.9**	**2.9**	**2.9**	**3.0**	**3.0**	**3.0**	**3.0**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	4.4	**2.9**	**2.4**	**1.5**	**1.5**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	10	6.5	13	15	19	24	29	29	28	46	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	4.3	3.9	**1.9**	3.7	3.4	3.4	3.4	3.4	3.4	3.6	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	3.7	**2.7**	**1.5**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**2.8**	**2.4**	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	4.4	3.1	**1.1**	**2.0**	**2.0**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1.5**	**2.2**	14	175	140	*42e-1/8e3*	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	24	8.6	**2.9**	*77e-1/1e5*	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	4.4	**2.4**	**1.1**	**1.7**	**1.8**	**1.9**	**1.9**	**2.0**	**2.0**	**1.9**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	4.2	**2.3**	**1**	**2.0**	**2.3**	**2.3**	**2.4**	**2.4**	**2.4**	**2.4**	IPOP-CMA-ES [14]
CMA+DE-MOS	17	8.9	3.6	3.4	3.9	4.7	5.9	5.9	5.9	5.9	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	36	*81e-1/5e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	21	24	68	1148	*77e-1/5e4*	.	.	.	.	.	Basic RCGA [16]
SPSA	341	1212	20969	*29e+0/1e5*	.	.	.	.	.	.	SPSA [8]

Table 13: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{113}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

113 Step-ellipsoid Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.26	20	343	1692	3158	3562	3586	3586	3586	3648	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	27	76	*37e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	3.8	13	38	*97e-1/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	58	12	437	*16e+0/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	4.0	157	*50e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1.1**	14	91	*13e+0/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1.2**	7.1	23	*77e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	12	10	15	*77e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	13	16	204	*19e+0/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1.9**	45	*40e+0/7e3*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	118	3.9	15	103	*11e-1/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	3.3	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**2.2**	**2.4**	**1.4**	**1.2**	**2.1**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	3.8	30	21	**19**	**17**	**17**	**17**	**17**	**17**	CMA+DE-MOS [12]
NEWUOA	12	36	*39e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1.0**	**2.1**	**3.9**	**7.4**	70	*53e-2/5e4*	.	.	.	.	Basic RCGA [16]
SPSA	72	6.0	*32e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 14: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{114}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

114 Step-ellipsoid unif

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.26	195	2191	5606	14972	16693	17094	17094	17094	17363	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	198	60	*98e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	94	63	*97e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	95	46	*83e+0/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	199	85	*11e+1/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	88	45	*82e+0/1e4*	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	104	14	*58e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	261	25	*79e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	153	59	*88e+0/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	40	38	*82e+0/7e3*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	10944	63	27	**127**	*41e-1/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	52	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1.4**	**1**	**1.1**	**1.5**	**1.3**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	6.0	*21e+0/1e5*	.	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	12	18	*88e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1.2**	**1.5**	**6.7**	*57e-1/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	4275	42	77	*14e+0/1e5*	.	.	.	.	.	.	SPSA [8]

Table 15: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{115}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

115 Step-ellipsoid Cauchy

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.26	6.7	36	390	1304	1794	1826	1826	1826	1862	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	8.4	3.8	12	188	*23e-1/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1.1**	**2.4**	**2.7**	12	115	*69e-2/1e4*	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	4.2	**1.8**	**2.2**	10	*65e-2/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**2.9**	5.3	16	*27e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1.6**	**1.4**	3.4	11	114	*75e-2/1e4*	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1.7**	**1**	**1.3**	11	51	*61e-2/1e4*	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1.0**	**1.1**	**1.7**	**7.7**	**33**	*39e-2/1e4*	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**2.7**	**1.4**	**2.9**	13	108	*69e-2/1e4*	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**2.7**	**1.5**	4.7	287	*24e-1/7e3*	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	71	7.2	4.4	708	*13e-1/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1.3**	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1.3**	**1.1**	**1.2**	**2.7**	**3.5**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	4.6	3.7	39	62	**84**	**83**	**83**	**83**	**81**	CMA+DE-MOS [12]
NEWUOA	4.1	**1.4**	21	*41e-1/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	3.5	41	34	178	398	391	391	391	383	Basic RCGA [16]
SPSA	68	23	38	*31e-1/1e5*	.	.	.	.	.	.	SPSA [8]

Table 16: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{116}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

116 Ellipsoid Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	304	1440	2445	3980	4537	4776	5016	5228	5443	5856	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	488	*59e+2/1e4*	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	236	*24e+2/1e4*	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	*28e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*55e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	45	*99e+1/1e4*	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	13	*36e+1/1e4*	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	42	*90e+1/1e4*	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	76	*13e+2/1e4*	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	336	*35e+2/7e3*	.	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	272	489	*70e+1/1e5*	.	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1.5**	**2.2**	**2.9**	**2.5**	**2.4**	**2.5**	**2.5**	**2.5**	**2.4**	**2.4**	IPOP-CMA-ES [14]
CMA+DE-MOS	8.4	16	**18**	**14**	**12**	**12**	**11**	**11**	**10**	**10**	CMA+DE-MOS [12]
NEWUOA	*28e+2/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**2.3**	**13**	95	*23e+0/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	1498	*29e+2/1e5*	.	.	.	.	.	.	.	.	SPSA [8]

Table 17: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{117}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

117 Ellipsoid unif

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	1301	5096	8105	13110	20449	22450	24596	26799	28946	37059	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	*44e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	*55e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	*51e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*76e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	*32e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	*33e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	*32e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	*39e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	*46e+2/7e3*	.	.	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	196	*13e+2/1e5*	.	.	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1.5**	**1.4**	**2.1**	**2.2**	**1.7**	**1.7**	**1.7**	**1.7**	**1.6**	**1.5**	IPOP-CMA-ES [14]
CMA+DE-MOS	34	99	**197**	*21e+1/1e5*	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	47	*51e+2/4e3*	.	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**2.0**	**20**	*12e+1/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	1139	*24e+2/1e5*	.	.	.	.	.	.	.	.	SPSA [8]

Table 18: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{118}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

118 Ellipsoid Cauchy

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	11	73	171	282	368	429	458	487	509	552	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	12	4.5	5.8	10	11	12	14	18	19	33	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	6.1	**2.2**	**2.3**	3.1	**2.8**	**2.7**	**2.7**	**2.6**	**2.7**	**2.7**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	4.9	**1.8**	**2.0**	**2.0**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	11	5.3	12	14	20	28	33	55	53	63	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	4.6	**1.8**	**1.9**	**2.3**	**2.3**	**2.3**	**2.4**	**2.6**	**2.7**	**2.8**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	3.8	**1.2**	**1.6**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.9**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**3.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	4.1	**1.6**	**1.6**	**1.7**	**1.5**	**1.5**	**1.5**	**1.5**	**1.6**	**1.6**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1.4**	13	*37e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	18	5.7	297	1423	3807	*60e-1/1e5*	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	4.0	**1.5**	**1.1**	**1.0**	**1.0**	**1.1**	**1.2**	**1.2**	**1.2**	**1.3**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	4.7	**2.2**	**2.3**	**2.6**	**2.6**	**2.6**	**2.6**	**2.7**	**2.7**	**2.7**	IPOP-CMA-ES [14]
CMA+DE-MOS	12	3.7	**2.6**	**2.1**	**2.1**	**2.3**	**2.6**	**2.8**	3.1	3.5	CMA+DE-MOS [12]
NEWUOA	**1.1**	**1.7**	45	*99e-1/5e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	30	185	947	*22e+0/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	25	57	8679	*29e+0/1e5*	.	.	.	.	.	.	SPSA [8]

Table 19: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{119}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

119 Sum of diff powers Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.19	17	376	606	1010	2457	5473	8198	11037	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	23	40	*38e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	4.1	12	119	*17e-1/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	10	11	380	*17e-1/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	19	51	*45e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**2.9**	18	185	*18e-1/1e4*	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	11	12	124	*14e-1/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	6.5	11	39	*10e-1/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	3.3	14	387	*21e-1/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	13	146	*65e-1/7e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	144	118	3.9	5.1	4.9	36	*32e-4/1e5*	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**2.7**	**2.7**	**1**	**1.3**	**1.4**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**2.9**	**1**	**1.0**	**1**	**1**	**1.6**	**2.1**	**2.3**	**2.6**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.6**	48	51	57	35	**17**	**10**	**6.6**	**5.5**	CMA+DE-MOS [12]
NEWUOA	**1**	6.0	90	*60e-1/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**2.5**	**2.5**	**2.6**	**2.9**	288	*22e-4/5e4*	.	.	Basic RCGA [16]
SPSA	80	63	6677	*10e+0/1e5*	.	.	.	.	.	.	SPSA [8]

Table 20: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{120}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

120 Sum of diff powers unif

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.23	291	2404	4229	11615	23539	40778	72104	1.36e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	135	145	*12e+0/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	175	51	*11e+0/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	204	41	*97e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	311	45	*95e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**10**	18	*67e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	103	9.3	*57e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	74	9.2	*65e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	36	21	*69e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	194	25	*97e-1/7e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	5333	5878	32	**17**	**22**	**10**	*34e-4/1e5*	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	49	**1**	**1.1**	**1.2**	**1.0**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	18	**1.1**	**1**	**1**	**1**	**1.2**	**1.4**	**1.1**	**1.0**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.3**	6.1	313	*44e-1/1e5*	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	79	25	*11e+0/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**1.1**	21	*80e-2/5e4*	.	.	.	.	.	Basic RCGA [16]
SPSA	2288	4227	49	*55e-1/1e5*	.	.	.	.	.	.	SPSA [8]

Table 21: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{121}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

121 Sum of diff powers Cauchy

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.19	8.0	23	38	71	161	319	514	1031	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	11	5.3	4.7	5.0	5.7	5.2	5.9	7.8	140	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	5.3	**2.2**	**1.8**	**1.9**	**2.1**	**2.2**	**2.4**	**2.7**	3.5	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**2.8**	**1.5**	**1.3**	**1.5**	**1.5**	**1.5**	**1.5**	**1.7**	**2.3**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	9.4	4.0	4.1	4.0	4.4	6.0	8.9	11	144	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	4.9	**1.4**	**1.7**	**2.1**	**2.2**	**2.4**	**2.3**	**2.9**	**2.5**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	6.8	**1.2**	**1.3**	**1.5**	**1.8**	**1.8**	**1.8**	**2.0**	**1.9**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	5.2	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	5.7	**1.0**	**1.4**	**1.5**	**1.6**	**1.5**	**1.3**	**1.4**	**1.4**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	8.3	**1.9**	216	2743	*76e-2/7e3*	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	142	107	7.7	7.0	6.8	19806	*20e-3/1e5*	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	3.8	**1.3**	**1.5**	**1.8**	**2.0**	**1.8**	**1.5**	**1.4**	**1.2**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**2.3**	**1.1**	**1.6**	**1.9**	**2.2**	**2.7**	3.2	3.3	3.5	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.6**	3.7	5.6	6.9	7.8	6.7	5.5	5.1	4.0	CMA+DE-MOS [12]
NEWUOA	**1**	4.2	3.1	303	*11e-1/4e3*	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**2.9**	16	20	49	964	*22e-4/5e4*	.	.	Basic RCGA [16]
SPSA	100	110	213	28929	*46e-1/1e5*	.	.	.	.	.	SPSA [8]

Table 22: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{122}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

122 Schaffer F7 Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.10	8.1	701	2889	4897	8620	10993	21803	58803	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1.1**	40	*41e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1.6**	8.9	*28e-1/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1.8**	12	*27e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	17	36	*45e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	4.1	13	*33e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1.2**	14	*26e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	4.1	8.0	*30e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**2.1**	15	*32e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	3.7	19	*42e-1/7e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	118	217	7.7	4.7	*10e-1/2e3*	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**2.5**	**1**	**1.4**	**1**	**1**	**1**	**1.2**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1.1**	**1**	**1.0**	**1.3**	**1.1**	**1**	**1.2**	**1.1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.4**	**2.5**	69	32	29	**20**	**16**	**10**	**4.5**	CMA+DE-MOS [12]
NEWUOA	**1**	**2.5**	30	*47e-1/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1.5**	**1.4**	**2.8**	**7.9**	**17**	24	*56e-3/5e4*	.	.	Basic RCGA [16]
SPSA	1.54e5	1.54e5	4506	*76e-1/1e5*	.	.	.	.	.	.	SPSA [8]

Table 23: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{123}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

123 Schaffer F7 unif

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.10	15	6209	24694	47823	79121	1.48e5	2.64e5	7.45e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	447	*82e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	85	158	*67e-1/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1.2**	180	*65e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	292	*71e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	38	*56e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	32	57	*46e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1.3**	42	*52e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1.1**	63	*61e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1.3**	48	*68e-1/7e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	9772	12675	189	*63e-1/5e3*	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**7.3**	**1**	**1.0**	**1.1**	**1.3**	**1.1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**2.0**	**5.9**	**1.0**	**1**	**1**	**1**	**1**	**1.0**	**1.3**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.4**	54	*42e-1/1e5*	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	31	51	*64e-1/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1.3**	**1**	*23e-1/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	1.14e6	1.15e6	93722	*66e+2/1e5*	.	.	.	.	.	.	SPSA [8]

Table 24: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{124}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

124 Schaffer F7 Cauchy

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.10	6.2	71	1122	3653	5485	8188	11405	17037	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1.3**	27	*45e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1.3**	**2.9**	165	*77e-2/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1.1**	**2.6**	131	*85e-2/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	218	*47e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	4.1	**1.6**	260	*12e-1/1e4*	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1.6**	**1.4**	96	*65e-2/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	3.1	**1**	64	*55e-2/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	3.1	15	957	*15e-1/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	3.5	7.0	*24e-1/7e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	112	177	8.3	**3.0**	31	*13e-2/5e3*	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1.1**	**1.0**	**1**	**1.0**	**1**	**1.1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	3.9	**1.1**	**1**	**1.4**	**1**	**1.2**	**1**	**1.5**	**2.0**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.4**	**1.9**	221	14	**6.7**	**5.2**	**4.2**	**3.6**	**3.0**	CMA+DE-MOS [12]
NEWUOA	**1**	5.0	6.5	*34e-1/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1.2**	**2.1**	11	**13**	10	14	*10e-4/5e4*	.	.	Basic RCGA [16]
SPSA	71512	71549	2956	*76e-1/1e5*	.	.	.	.	.	.	SPSA [8]

Table 25: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{125}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

125 Griewank-Rosenbrock Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.10	0.10	3.9	22979	69545	1.68e5	2.58e5	2.59e5	2.63e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	**1**	69	*50e-2/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	**1**	31	*39e-2/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**1**	12	*41e-2/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	**1**	122	*54e-2/1e4*	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**1**	24	*38e-2/1e4*	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**1**	10	*37e-2/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**1**	13	*34e-2/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**1**	33	*40e-2/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	5.9	**1**	*19e-2/7e3*	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	129	163	186	9.4	**1**	**4.8**	*14e-3/1e5*	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	**2.9**	**1.2**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1**	**2.4**	**1.2**	**1.2**	**1.2**	**1.1**	**1.1**	**1.1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	**1.1**	11	**1.4**	23	*26e-3/1e5*	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	3.8	**2.1**	*22e-2/4e3*	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**1.1**	4.5	**2.0**	*88e-3/5e4*	.	.	.	.	Basic RCGA [16]
SPSA	71510	71522	71531	1817	12	*12e-2/1e5*	.	.	.	.	SPSA [8]

Table 26: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{126}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

126 Griewank-Rosenbrock unif

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.10	0.10	15	1.11e5	1.92e6	6.27e6	∞	∞	∞	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	**1**	345	*88e-2/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	**1**	209	*74e-2/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**1**	385	*84e-2/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	**1**	364	*86e-2/1e4*	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**1**	72	*59e-2/1e4*	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**1**	60	*56e-2/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**2.9**	55	*57e-2/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**1**	62	*72e-2/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	9.4	335	*89e-2/7e3*	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	2497	3030	3915	95	4.1	*12e-2/1e5*	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	**2.1**	**2.8**	**1**	**1**	*80e-3/3e5*	.	.	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1**	3.8	**3.2**	*86e-3/3e5*	.	.	.	.	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	**1.1**	**3.3**	6.4	*17e-2/1e5*	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	29	80	*66e-2/4e3*	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**1.1**	**1**	**1**	*12e-2/5e4*	.	.	.	.	Basic RCGA [16]
SPSA	1.40e7	*89e+2/1e5*	.	.	.	.	.	.	.	.	SPSA [8]

Table 27: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{127}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

127 Griewank-Rosenbrock Cauchy

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.10	0.10	4.0	3514	32104	76636	1.01e5	1.03e5	1.05e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	**1**	10	*30e-2/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	**1**	3.4	14	*18e-2/1e4*	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**1**	3.2	41	*22e-2/1e4*	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	**1**	13	*34e-2/1e4*	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**1**	**2.9**	6.0	*15e-2/1e4*	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**1**	**1.9**	4.5	*11e-2/1e4*	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**1**	**2.4**	4.2	*12e-2/1e4*	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**1**	3.0	13	*15e-2/1e4*	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	**1**	**1**	*20e-2/7e3*	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	115	148	159	10	13	*72e-3/1e5*	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	**1.9**	**2.1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1**	**1.6**	**3.1**	**1.6**	**1.4**	**1.3**	**1.3**	**1.3**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	**1.1**	6.8	**1**	**2.5**	*66e-4/1e5*	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	**2.4**	**2.0**	*25e-2/4e3*	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**1.2**	5.1	6.4	*25e-3/5e4*	.	.	.	.	Basic RCGA [16]
SPSA	112	144	652	3311	403	*59e-2/1e5*	.	.	.	.	SPSA [8]

Table 28: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{128}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

128 Gallagher Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.10	429	30306	71512	73883	75123	1.17e5	1.18e5	2.16e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	330	*15e+0/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	18	**2.2**	**2.0**	*80e-1/1e4*	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	32	*78e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	165	*20e+0/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	24	*81e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	7.8	**1.5**	*46e-1/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	14	**1**	*53e-1/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	21	*82e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	69	*21e+0/7e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	124	170	**4.5**	3.1	**1.3**	**1.7**	**2.1**	**2.5**	**2.4**	3.1	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1.4**	13	5.7	**5.5**	5.4	3.5	3.5	**1.9**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1**	13	5.7	5.5	**5.4**	**3.5**	**3.5**	**1.9**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	110	23	10	21	20	13	13	7.1	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	*24e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	7.0	**2.2**	**1**	**1**	**1**	**1**	**1**	**1**	Basic RCGA [16]
SPSA	79	101	*64e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 29: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{129}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

129 Gallagher unif

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.10	3382	3.45e5	5.59e5	5.61e5	5.63e5	5.66e5	5.68e5	7.14e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	*44e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	*34e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	43	*32e+0/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	44	*38e+0/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	21	*21e+0/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	*24e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	*23e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	*28e+0/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	*39e+0/7e3*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	5487	16432	21	**2.1**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.1**	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1.0**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1**	**2.0**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	41	*11e+0/1e5*	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	*39e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**7.1**	**1.1**	*65e-1/5e4*	.	.	.	.	.	Basic RCGA [16]
SPSA	1935	9633	*41e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 30: 10-D, running time excess ERT/ERT$_{\text{best}}$ on f_{130}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

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Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.10	0.10	92	1340	2887	2897	2907	2919	2930	2951	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	6.3	18	11	11	11	10	10	10	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	5.2	**2.8**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**2.3**	**1.0**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	5.9	3.5	3.4	4.0	4.5	5.6	8.1	8.1	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**2.7**	**2.6**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**2.0**	**2.4**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**1.5**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**2.6**	**2.5**	**2.2**	**2.2**	**2.2**	**2.2**	**2.1**	**2.1**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	**1**	**2.6**	11	*41e-2/7e3*	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	108	153	**1.3**	53	53	97	482	*15e-2/1e5*	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1.2**	136	63	63	63	62	62	62	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1.9**	256	164	164	163	162	162	161	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	170	166	105	105	104	104	103	103	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	**1.4**	4.9	10	21	21	*14e-1/4e3*	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	28	24	14	14	15	15	23	57	Basic RCGA [16]
SPSA	121	152	582	*73e-1/1e5*	.	.	.	.	.	.	SPSA [8]

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